A MONOGRAPH OF THE AUSTRALIAN *MARSIPOBRANCHII*.

By J. Douglas Ogilby.

In the present paper I have endeavoured to reduce to some appearance of order the history of the Australasian Lampreys and such meagre and for the most part inaccurate literature as appertains thereto. It is undeniable that some such work had become necessary owing to the diversity of the views held by the various writers who have approached the subject, and which culminated in the recognition by Sir William Macleay of four genera and six species, two of the former and an equal number of the latter having been founded on ammocœtal or immature individuals; this list I have found it necessary to reduce to three genera, each of which is represented by a single species.

The first author to whom the honour of recording the existence of a hyperoartian Marsipobranchiate in the southern hemisphere is due is Sir John Richardson, who, under the name of *Petromyzon mordax*, described and figured a species in the Ichthyology of the Erebus and Terror; six years later Dr. John Edward Gray published a "Synopsis of the *Petromyzonidæ*" in the Proceedings of the Zoological Society of London, in which Richardson's species is made the type of a new genus *Mordacia*, while for a closely allied form from the rivers of Chile a second genus, *Caragola*, is proposed. Besides these the same paper contains descriptions and figures of two other austrogæan genera, namely, *Geotria*, founded on a specimen picked up on the beach in Hobson's Bay (*see p.* 425) by Mr. R. A. Pain, and by him forwarded to the British Museum; and *Velasia*, the type of which was a Chilian specimen in the collection of the same institution.

In a series of three papers (1857-1863) Philippi gave some particulars as to the Chilian Lampreys, and described two new species as *Petromyzon anwandteri* and *acutidens*; these papers appeared in Wiegmann's Archiv.

In the Annals of the Museum of Buenos Aires for 1868 Burmeister described a very curious form under the name of *Petromyzon macrostomus*, and as this Lamprey has no place in the Australasian fauna it may be dismissed here with the remark that it forms the type of a genus *Exomegas*, Gill (*see p.* 425), and is very rare, only two examples being known to science, the first having been picked up in the streets of Buenos Aires, and the second collected in the Bay of Monte Video.

Two years subsequently to the publication of Burmeister's paper the eighth volume of Dr. Günther's Catalogue of Fishes appeared, and his treatment of the conclusions of previous authors is, to say the least of it, revolutionary; as a commencement *Mordacia mordax*, Gray, from Tasmania, *Caragola lapicida*, Gray, *Petromyzon anwandteri*, Philippi, and *P. acutidens*, Philippi, all three from Chile, are associated under the common name *Mordacia mordax*, though the author had at his disposal only Dr. Gray's two original specimens, one of which was in a notoriously bad condition; even the selection of the generic name was unfortunate, *Caragola* having a slight precedence over *Mordacia*, and though, for reasons hereafter stated, I have adopted the name *Mordacia*, it is not to be expected that all other authors will be equally complaisant,* and we shall, therefore, be cumbering our pages with a dual synonymy, one school of writers adhering to *Mordacia* while the other as strenuously upholds the claims of *Caragola*; all which confusion would have been avoided by the initial attention to the strict rules of nomenclature. Continuing, Dr. Günther united Gray's *Geotria* and *Velasia*, a conclusion which is not borne out by a more careful examination of the two forms, and announced the occurrence of the latter in New

* Eigenmann & Eigenmann in "A Catalogue of the Fresh-water Fishes of South America" (Proc. U.S. Nat. Mus. xiv. 1891, p. 24) call the Chilian species *Caragola mordax*, thus possibly further confusing the synonymy as it is very unlikely that the Australian and Chilian forms are identical, and in view of my own discoveries in regard to the marked differences between *Velasia* and *Geotria* it is at least possible that both *Caragola* and *Mordacia* may be valid.

Zealand waters, determining the species found there as Gray's *chilensis*, in which identification also I am not prepared to follow him; he also records under the same name a Lamprey from "Swan River," but whether this is the well known river of West Australia or some other does not appear (*see p.* 419). In the following year the same author described a new species of *Geotria* from Tasmania as *G. allporti*, a proceeding which appears unnecessary.

With this description the history of the Australasian Lampreys as species, so far as exotic writers are concerned, ceases, with the exception of two notices by Dr. Klunzinger of the occurrence of *Mordacia mordax* in the estuary of the Murray in 1873, and of *Geotria australis* as far west as King George's Sound in 1880.

With the cessation of outside interest in our Lampreys and the conclusion of the British Museum Catalogue, an unwonted and most gratifying activity on the subject of our fishes began to be manifested by Australian writers, and among the rest the Lampreys came in for their full share of attention.

The year 1872 is memorable for the production of two important essays, one of these being "The Fishes of New Zealand" by Capt. Hutton, to which was appended a short account of the edible species from the pen of Dr. Hector; the other, and in many respects the more important of the two, was contributed by Count Castelnau to the Proceedings of the Zoological and Acclimatisation Society of Victoria under the title of "A Contribution to the Ichthyology of Australia." Both these authors, and indeed all subsequent Australasian writers, accept Dr. Günther's synonymy without comment or protest.

In the first essay alluded to only Günther's *Geotria chilensis** is mentioned, his description being copied direct from that author's work, with the addition of certain rivers specially referred to as being frequented by that species. And, as it must be done sooner or later, I may as well take this opportunity of entering a strong

* *G. australis* was added to the New Zealand fauna in the following year by Capt. Hutton.

protest against the practice which is so prevalent among writers on our fishes of copying the descriptions and remarks from the British Museum Catalogue without any attempt being made to test their accuracy, and by so doing perpetuating error, creating confusion, and indefinitely postponing the dawn of that accurate knowledge of our native fauna which every admirer of the marvellous products of our country must ardently desire.

Very different, however, is Count Castelnau's contribution; in it we find by far the best account of two of our species as yet published, and though in the case of one of them the author had evidently determined the species wrongly, this does not detract from the value of his remarks, while the very accuracy of his description has enabled me to correct his error without difficulty, a thing which would have been impossible had he also been content to be a mere copyist. Following his usual practice he has, however, given generic and specific names to two individuals, one of which was an ammocœte while the other had only just passed through its metamorphosis and assumed the habits and in part the dentition of the adult. Count Castelnau's long experience should have taught him to avoid this pitfall. His paper, therefore, increased the number of Australasian species to six, distributed among four genera, and at this they have been left up to the present time by all writers, even Sir William Macleay republishing without comment the descriptions of these nominal species in his Catalogue of Australian Fishes, where, at least, we might have expected that some effort would have been made to correct the errors of his predecessors.

I append here in parallel columns the names of the species as given by Macleay and those which I recognise as valid in the following paper :—

Mordacia mordax	*Mordacia mordax.*
Neomordacia howittii	*Velasia stenostomus.*
Geotria chilensis	
Yarra singularis	
Geotria australis	*Geotria australis.*
Geotria allporti	

In connection with the reinstatement of Gray's *Velasia* I wish to call the attention of those who may have the opportunity of examining this genus and *Geotria* during the ammocœtal stage and immediately after the metamorphosis has taken place, to the significance of the dental furrows in the latter genus; from the examination of the adult it appears to me that the evolution of the laminæ in *Geotria* will prove to be materially different from that which holds good for *Velasia*.

Finally, it is hoped that the present paper will not only throw some light on the affinities of these various forms, but also induce some of our southern naturalists to spare time for the study of these interesting animals, of whose life history much still remains to be learnt.

Class MARSIPOBRANCHII.

The Myzons.

Skeleton membrano-cartilaginous; skull imperfectly developed, not separate from the vertebral column, which consists of a stout notochord enveloped in a fibrous sheath; neural cartilages present, small; hæmal sheath present in the caudal region only. Lower jaw, ribs, limbs, shoulder-girdle, and pelvic elements wanting. Gills six or more on each side, represented by fixed sacs and destitute of branchial arches. Mouth suctorial and subinferior, more or less circular, with or without lips. Nasal aperture single. Eyes present or absent. Vertical fins present, usually continuous around the tail, supported by feeble rays, which are rarely articulated or branched; no paired fins. Skin naked. Heart without arterial bulb. Air-vessel absent. Alimentary canal straight, little dilated, without pyloric appendages, pancreas, or spleen. Generative openings peritoneal.

Etymology:—*μαρσίπιον*, a pouch; *βράγχια*, gills; in allusion to the sac-like formation of these organs.

Distribution:—Seas and rivers of the temperate regions of both hemispheres, no species having as yet been discovered either in high polar latitudes or within the tropics.

Geologically the Cyclostomes date back to the Lower Devonian.

Up to the present time but little has been definitely proven with regard to the degree of relationship which exists between the Marsipobranchiates on the one hand and the more recently and highly developed Teleostomes on the other, but the preponderance of evidence tends to show that the former are the survivors of a very primitive type of the Chordates, the oldest living representatives of which are to be found among the *Heptatrematidæ*.

The *Marsipobranchii* are divisible into two Orders, which may be briefly characterised as follows :—

Nasal duct tube-like, penetrating the palate; mouth without lips; eyes wanting; snout with barbels ... ...
HYPEROTRETI*

Nasal duct a blind sac, not penetrating the palate; lips and eyes present; no barbels ... ...
HYPEROARTII†

The first of these Orders contains two Families, the *Heptatrematidæ* and the *Myxinidæ*, the members of which are variously known as Hag-Fishes or Borers; they are small, colourless, more or less parasitic, marine animals, living at a moderate depth, and wholly carnivorous. In places where they are common they do no inconsiderable damage to the fishermen by destroying the hooked fishes, into whose body they burrow and upon whose tissues they feed internally. They inhabit nearly all the seas of temperate regions, and three genera, *Polistotrema*,‡ *Heptatrema*,‖ and *Myxine*§ have been differentiated.

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* ὑπερῶα, palate; τρητός, perforated.

† ὑπερῶα, palate; ἄρτιος, entire.

‡ *Polistotrema*, Gill, Proc. U.S. Nat. Mus. 1881, p. 30. Type, *Gastrobranchus dombey*, Lacépède. πολύς, many; ἱστός, vertical; τρῆμα, a perforation; in allusion to the increased number of external gill-openings.

‖ *Heptatrema*, Dumeril, ? Diss. Poiss. Cyclost. Type, *Petromyzon cirrhatus* (Forster), Bloch & Schneider. ἑπτά, seven; τρῆμα, a perforation; = *Bdellostoma*, Müller, Abh. Ak. Wien, 1834, p. 79 (1836).

§ *Myxine*, Linnæus, Syst. Nat. i. 1758. Type, *Myxine glutinosa*, Linnæus. μυξῖνος, a slimy fish, from μύξα, slime; so named on account of the excessive amount of slime secreted by the mucous sacs of these animals, which is so great that the exudation from a single living example is sufficient to gelatinise a pailful of water.

So far, however, no Hyperotrete can be satisfactorily recorded as having occurred within our limits, but *Heptatrema cirrata*, being an inhabitant of the New Zealand seas, may occur or be represented by an allied form on our coast.*

The following synopsis will serve to show the most obvious characteristic of the three genera.

Eleven or more branchial apertures on each side; the base of the tongue situated between the seventh and eighth pair of branchiæ ... ... POLISTOTREMA.

Six or seven branchial apertures on each side; the base of the tongue situated between the anterior pair of branchiæ ... HEPTATREMA.

A single branchial aperture on each side ... ... MYXINE.

In all probability each genus is represented by a single valid species only; sexually they are hermaphrodite, but the ova and sperm attain maturity in each individual at a different period, the ripening of the latter taking place earlier in life than that of the former.

Order HYPEROARTII.

The Lampreys.

Body anguilliform, naked, compressed or subcylindrical in front, compressed behind; mouth subcircular or oval, suctorial; lips present, usually fringed, but without barbels; nostril at the upper surface of the head, the nasal duct a blind sac, not penetrating the palate. Eyes present, small. Branchial apertures seven on each side, situated behind the head, the inner branchial ducts terminating in a common tube. Teeth cuticular, horny, simple or multicuspid, resting on soft papillæ, those immediately above and immediately below the opening of the œsophagus more or

* Krefft indeed (Australian Vertebrata, p. 779) gives, under the heading of *Bdellostoma cirrhatum*, the locality "New Zealand and Australian Rivers"; but this is obviously a mistake and refers to one of the Lampreys.

less specialised. Dorsal fin more or less deeply divided by a notch, the posterior portion usually continuous with the caudal. Intestine with a rudimentary spiral valve. Eggs small, fertilised after extrusion. Sexes separate.

Etymology:—*ὑπερῶα*, palate; *ἄρτιος*, entire: in reference to the non-perforation of the palate by the nasal duct.

Distribution:—Seas and rivers of the temperate zones of both hemispheres.

All the Lampreys are subject to a metamorphosis; during the earlier stage of their existence, when they are known as *ammocœtes*, the eyes are in a rudimentary condition and they are entirely without teeth, their food consisting solely of vegetable substances gathered from the mud in which they live.

These ammocœtes are not unfrequently found of an equal or even larger size than individuals of the same species in which the eyes and teeth have already undergone development, this being due to arrested growth of these organs on the part of the individual.

Several distinct genera, such as *Ammocœtes*, *Scolecosoma*, &c., have been constituted for the inclusion of these immature forms.

The suctorial disk which is so characteristic of the Lampreys is useful to them in various ways; it serves as an instrument by means of which they are able to adhere to rocks, piles, sunken logs and the like, and so resist the force of the current and escape the necessity for such continuous and violent muscular exertion as would be imperative in an animal possessed of such feeble swimming powers; by it they are able during the spawning season to remove stones and similar obstructions from that portion of the river bed which has been selected as suitable to the formation of the nesting-place or "redd," and, after the task of depositing the ova has been completed, to replace the stones, and so minimise the danger to which the eggs would be exposed in the event of the occurrence of heavy floods during the period of incubation; and finally, by it they are enabled to attach themselves to the substances which form their food.

Up to the year 1894 ichthyologists were content to segregate the various species of Lampreys in a single family, to which the name *Petromyzontidæ* had been given by Risso as early as 1826 (*Eur. Mérid. iii. p. 99*), the title being altered six years later by Bonaparte (*Saggio, &c. p. 41*) to the more correct orthographic reading *Petromyzonidæ*. So long ago, however, as 1882 Dr. Gill (*Proc. U.S. Nat. Mus. v. p. 524*) proposed to separate the genus *Mordacia* (= *Caragola*) from the remaining *Hyperoartii* in a subfamily *Caragolinæ*. In the volume of the same periodical for 1894 (*p. 109*) the same author went a step further and raised his *Caragolinæ* to family rank under the name *Mordaciidæ*, he having in the meanwhile become reconciled to the use of *Mordacia*.

In this later paper the author, in support of the proposed family, pertinently remarks :—"It behooves those who may object to these families to consider why the character used to distinguish them should not be of equal value with the union or separation of the lower pharyngeal bones and like modifications generally used."

As Dr. Gill's contention appears to me to be perfectly sound, I have accepted the families as here defined by him.

Analysis of the Families of the Hyperoartii.

Two distant lateral tuberculigerous laminæ developed from the upper arch of the annular cartilage .. ..
MORDACIIDÆ.

A single median tuberculigerous suproral lamina developed from the upper arch of the annular cartilage ... .
PETROMYZONIDÆ.

There is one other character separating these two families, namely, the labial fringes, which taken in conjunction with the more perfect dentition of the former, appears to me worthy of special notice; all the *Petromyzonidæ* are provided with a more or less conspicuous fringe of papillæ around the outer rim of the suctorial disk, which fringe is rudimentary in *Mordacia*. If we look upon these papillæ as having developed from the oral barbels of the more ancient *Hyperotreti*—and in so doing I scarcely think that we are

assuming too much—it follows that both in this character as well as in the dentition the Mordaciids have attained to a higher degree of development than the Petromyzonids.

Mordaciidæ.

Caragolinæ, Gill, Proc. U.S. Nat. Mus. v. 1882, p. 524.

Mordaciidæ, Gill, Mem. Nat. Acad. Sc. vi. p. 129, 1893 (*no definition*) *and* Proc. U.S. Nat. Mus. xvii. 1894, p. 109.

Two distant lateral tuberculigerous laminæ developed from the upper arch of the annular cartilage. Labial fringe rudimentary. Other characters similar to those of the Order.

One genus only.

Distribution:—Seas of South-eastern Australia, Tasmania, and Chile; entering fresh waters for the purpose of breeding.

Mordacia.

Caragola, Gray, Proc. Zool. Soc. London, 1851, p. 239.

Mordacia, Gray, *l.c.*

Body elongate and slender, subcylindrical in front, the tail and a part of the body compressed; head small, oblong, attenuated, and somewhat depressed, with slightly pointed snout; suctorial disk moderate, oval, subinferior, extending backwards to the orbital region, with a well developed simple external lip, between which and the rim of the disk is inserted a regular series of short papillæ; rim of disk thin, forming a free, simple, cutaneous flap behind; surface of disk feebly plicated on its outer, smooth on its inner moiety. No gular pouch.* Branchial orifices small and subcircular, with a low raised rim and a well developed valve inserted anteriorly. Maxillary dentition consisting of two subtriangular plates, each of which is provided with three strong, sharp, hooked cusps, arranged in the form of a triangle; mandibular plate low and crescentic,

* The Chilian *Mordacia* is said by Philippi to be occasionally provided with a gular sac; this has never been observed in the Australian species, and is most unlikely.

cuspidate; disk with three strong unicuspid teeth anteriorly, the basal pair followed by two or three similar teeth, the sides and hinder portion with a series of broad tri- or bicuspid lamellæ; a row of small teeth inside the rim of the disk; tongue with two pairs of narrow multicuspid plates inserted on its dorsal surface and a finely cuspidate transverse plate below. Dorsal fin originating a short distance behind the middle of the body, divided into two portions (in the adult) by a short interspace, the anterior small, the posterior much larger and more or less continuous with the caudal, which is free or nearly so. Tail moderate, the vent situated well behind the middle of the second dorsal fin. No conspicuous series of pores on the head or body.

Etymology:—*Mordax*, voracious.

Type:— *Mordacia mordax*, Gray = *Petromyzon mordax*, Richardson.

Distribution:—South-eastern Australia, Tasmania, and Chile.

The absence of this genus from the New Zealand fauna when contrasted with its South American range is somewhat remarkable.

With regard to the propriety of retaining the generic name *Mordacia* for these Lampreys in place of *Caragola*, which both by a slight priority and by a more accurate diagnosis is fairly entitled to selection, I cannot do better than to quote the opinions of Drs. Gill and Boulenger as follows:—

The former remarks (*Proc. U.S. Nat. Mus. 1894, p. 109*):— "In 1882 I used in preference the first name (*Caragola*) based on a perfect individual. I have since been led to believe that the precedence of one name by such a little margin as *Caragola* has over *Mordacia* has no value, and that aptness of diagnosis, however desirable, is not necessary to procure priority, and I have, therefore, followed Dr. Günther in accepting the name *Mordacia* instead of *Caragola*."

Dr. Boulenger writes (*in lit.*): "I cannot agree with you that the fact of one name appearing before another in the same book

constitutes priority, and it would be a pity to alter the well known name *Mordacia* to *Caragola*."

It is only in deference to the opinions as expressed above, of two so eminent scientists, that I have decided to adhere to the more generally accepted name *Mordacia*; nevertheless it is due to myself to say that the substitution of that name for *Caragola* is distinctly repugnant to me; so long as the rule remains in force, which provides that the earliest name, all other requirements having been complied with, shall take precedence, I cannot coincide with the contention that the accident of two names being published in the same volume, or even, as in this case, on the same page of the same volume, can under any circumstances justify our rejection of the earlier in favour of the later name; by so doing we are assisting to open a rift which may in course of time imperil the stability of the entire fabric; while the plea that a name should be retained because it is better known is sentimental and unsound, and therefore unworthy of consideration.

As is the case with all the Lampreys the dentary plates are provided with a horny covering, which may easily be removed in layers, but except for the necessary decrease in size both of plate and cusps consequent on the removal of each separate layer, no alteration in their appearance is noticeable, unless the entire corneous lamina be lost, and the underlying papillary prominence be thus exposed to view.

Gray's description of *Mordacia* was based on a specimen from Tasmania, the dentition of which was imperfect through the loss of the corneous lamellæ of many of the plates, while his type of *Caragola* was a Chilian example in which the lamellæ were intact; the diagnosis of *Caragola* is therefore more correct; surely an additional argument for the retention of that name.

Some interesting remarks on the pineal eye in this Lamprey, from the pen of Prof. Baldwin Spencer, will be found in the Proceedings of the Royal Society of Victoria, Vol. ii. 2nd Series, p. 102, 1890.

MORDACIA MORDAX.

Petromyzon mordax, Richardson, Voy. Erebus & Terror, Ichth. p. 62, pl. xxxviii. ff. 3-6*, 1845.

Mordacia mordax, Gray, Proc. Zool. Soc. London, 1851, p. 239, pl. iv. f. 6†, *and* Catal. Chondropt. p. 144, pl. i. f. 6, 1851; Günther, Catal. Fish. p. 507, 1870; Klunzinger, Arch. f. Natur. xxxviii. 1872, p. 45, *and* Sitzb. Ak. Wien, lxxx. i. 1879, p. 429 (1880); Castelnau, Proc. Zool. & Acclim. Soc. Vict. i. 1872, p. 229, *and* Edib. Fish. Vict. p. 17, 1873; Macleay, Proc. Linn. Soc. N.S. Wales, vi. 1881, p. 382; Johnston, Proc. Roy. Soc. Tas. 1882, p. 141 (1883), *and* 1890, p. 39 (1891); Stephens, Proc. Linn. Soc. N.S. Wales (2) i. 1886, p. 506; Lucas, Proc. Roy. Soc. Vict. (2) ii. 1890, p. 46.

Short-headed Lamprey.

Disk oval, its width when fully expanded somewhat less than its length, its posterior margin reaching to or nearly to the level of the eyes. Eyes conspicuous, the nasal tube opening a little in advance of their anterior margins. The distance between the extremity of the snout and the nasal opening is 21 to $26\frac{1}{2}$ in the total length and $1\frac{3}{4}$ to 2 in that preceding the first branchial orifice, which is situated a little nearer to the last orifice than to the tip of the snout; the space between the last‡ orifice and the extremity of the snout is $6\frac{1}{5}$ to $6\frac{4}{5}$ in the total length. Maxillary plates widely separated; each plate is armed with three strong, acute cusps, the tips of which are directed slightly backwards; they are arranged in the form of a triangle, having the apex in

* Richardson's figure is unreliable, being taken from a specimen in which the lateral corneous lamellæ had been lost, a single papillary prominence alone being left to represent each plate.

† Copied from Richardson.

‡ In Richardson's description this measurement is erroneously given as the space in front of the *first* gill-opening.

front, the anterior cusp being rather stronger than the basal pair; mandibular plate with nine cusps, the last but one (rarely the last two) on each side much enlarged, the median one generally so; the discal dentition consists of three strong teeth anteriorly, the basal pair being on a line with the inner borders of the maxillary plates; they are similar in shape and arrangement to each triad of maxillary cusps, but differ in being entirely disconnected, though contiguous, at their bases; behind these a series of broad sharply-ridged lamellæ extends backwards along the sides of the disk close to the gular cavity and is continued behind the mandibular plate; each lamella is furnished with a strong cusp near its inner extremity and a smaller one at its outer, the lateral ones having a supplementary cusp outside and partially behind the inner cusp; between the discal lamellæ and the rim of the disk there is a row of small, sharp, hooked teeth; tongue with two narrow elongate plates arranged along each side of its dorsal aspect; the anterior pair are almost parallel, the distal extremity, however, being curved outwards and backwards, and armed with seven or eight fine subequal cusps and an enlarged terminal cusp, while on the linear portion seven cusps are present, the middle ones being the longest and the terminal one small; the posterior and outer pair of plates are inserted obliquely, with the convergent ends in front and in contact with the middle of the base of the inner plates; each is furnished with from twelve to fourteen fine cusps, which gradually decrease in size from the front; the ventral surface is armed at the base with a deep, transverse, V-shaped plate, the apex of which is radical; the outer border of each limb forms a deep concavity, which terminates in a stout, hooked cusp, outside the base of which the plate is curved inwards and backwards, both the recurved portion and the limb itself being armed with comb-like cusps, two or three of which on either side of the apex, are somewhat enlarged. The vent is situated beneath or a little in advance of the commencement of the last third of the second dorsal fin; the length of the tail is $6\frac{2}{3}$ to $7\frac{4}{5}$ in the total length. The distance between the origin of the dorsal fin and the tip of the tail is $1\frac{1}{4}$ to $1\frac{2}{5}$ in its distance from

the extremity of the snout; the anterior portion of the fin is small and evenly convex, and passes imperceptibly into the dorsal integument at both ends; the length of its base is from 1 to $1\frac{1}{5}$ in the interspace between the two divisions of the fin and $2\frac{1}{5}$ to $2\frac{1}{2}$ in the base of the second portion, which is connected with the caudal fin by a more or less conspicuous rayless membrane;* the lower lobe of the caudal is more developed than the upper, to which it is joined round the extremity of the tail by a membrane similar to that which connects it with the dorsal. Head and body without conspicuous pores.

In the ammocœte both the dorso-caudal and the intercaudal membranes are well developed and the dorsal is continuous, but in large examples the intervening membranes have entirely disappeared.

In the Nepean specimen (125 millimeters) the dorsals are connected by a low cutaneous fold, as also are the second dorsal and caudal, the fold in this case being almost as high as the latter fin but rayless; the lower lobe of the caudal extends forwards to the vent, and there is also a distinct fold for a considerable distance in front of the vent; the maxillary teeth are as large as in the adults.

Upper surfaces rich olive brown, the sides golden brown, lighter below; lower surface of the head and the throat silvery; fins greenish yellow.

Castelnau's description of the colours, taken from a recent specimen, is as follows:—

"Bluish gray, darkest on the back; head yellowish; eye silvery; first dorsal gray; second bordered with pink, its posterior part black; caudal black, with a pink margin."

The earliest intimation of the occurrence of a Lamprey in the Australasian Colonies is to be found in the Ichthyology of the Erebus and Terror, where Sir John Richardson describes this species from a Tasmanian example, without, however, separating it from the arctogæan genus *Petromyzon*; six years later, however,

* In large examples even this disappears.

Dr. Gray, when engaged on his Catalogue of Chondropterygians rightly removed the Tasmanian species from that genus under the name *Mordacia*, and further proposed for a very similar Chilian Lamprey the name *Caragola lapicida*, the generic differences relied on being due to the defective dentition of the former.

In 1863 Philippi (*Wiegm. Arch. p. 207, pl. x. f. b.*) described and figured a Chilian species under the name of *Petromyzon anwandteri*, and in the following year (*l.c. p. 107, and Ann. & Mag. Nat. Hist. 3rd. ser. xvi. 1865, p. 221*) described yet another species from the same territory as *P. acutidens*.

All these various forms, Tasmanian and Chilian, were united together by Dr. Günther in 1870 under the common name *Mordacia mordax*, a conclusion which—seeing that he had but a single example from each so widely separated locality, and that one of these (the Tasmanian) was admittedly in bad condition—is so manifestly inconsiderate that I prefer to regard the Chilian form distinct from that described by Richardson until conclusive evidence to the contrary shall have been brought forward.*

Breeding:—The habits of the Short-headed Lamprey during the breeding season are quite unknown, but it is not probable that they differ in any marked degree from those of the more carefully studied arctogæan species.

In the typical genus *Petromyzon* the eggs are minute, of spherical form, and number many thousands; the ova and sperm fall first into the body cavity and are emitted from thence through the abdominal pores; each ovum is enclosed in a delicate gelatinous membrane; fertilization takes place in the water after extrusion; and the eggs arrive at maturity simultaneously after the lapse of about a fortnight.

An interesting account of the spawning habits of a species of *Petromyzon* is given by Prof. McClure and Dr. Strong, from

* "Less confusion arises from calling them"—*i.e.*, species from remote districts—"different until shown to be the same, than from calling them alike until shown to be different" (*David S. Jordan, in lit.*).

observations made by them in the neighbourhood of Princeton, New Jersey.

According to these authorities the eggs are deposited in shallow and clear water, so that the movements of the animals may readily be followed; the breeding season is in spring and the Lampreys remain upon the spawning grounds for two or three weeks; the nests are scattered thickly about the gravelly shoals, often only a few feet apart. Each nest is occupied by several males and but a single female, which is conspicuous on account of its greater size.* When engaged in the act of spawning the Lampreys press together and cause a flurry in the water at the moment when the eggs and milt are in process of emission. Three or more layers of eggs are thus deposited, each layer being covered by a thin sheet of sand or gravel, the parents always returning to the same nest. When all the ova have been deposited, the nest is strengthened by a dome-like mass of pebbles and stones which the Lampreys carefully drag to the spot; the nest is thus marked out as well as protected, and is said to be made use of during the ensuing season.†

The suctorial disk is used to keep the parents in position during the period of the emission of the spawn.

U s e s :—All the Lampreys are esteemed as food, and there is no reason to believe that the present species differ in this respect from the others; in fact, Castelnau distinctly states "that they are good food."

D i s t r i b u t i o n :—South-eastern Australia and Tasmania.

Athough long known from the neighbouring colonies of Tasmania and Victoria no record of the occurrence of a Lamprey in New South Wales waters had been furnished up to 1886, when the late Prof. Stephens exhibited a young example of this species

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* Other observers insist that only one pair frequent each nest.

† See Bashford Dean, Fishes Living and Fossil, p. 182; consult also Gage, Lake and Brook Lampreys of New York, in Wilder, Quarter-Century Book, pp. 421-493, 1893.

at the May meeting of the local Linnean Society; this specimen, which is in the Macleay collection at the Sydney University, was obtained from the Nepean River, near Camden, but though efforts have since been made to obtain other examples in the same district they have hitherto resulted in failure.

Additional and reliable evidence of its presence in the Hawkesbury watershed has, however, been afforded by Mr. J. P. Hill, of the University, who informs me that a friend of his is acquainted with this Lamprey and has caught it in the Wollondilly by the following ingenious method:—a pickle bottle is baited with a piece of raw meat and, a string having been tied round its neck, is sunk in a likely spot; the animals enter the bottle to feed, and on perceiving the motion consequent on its periodical withdrawal, attach themselves thereto by means of the suctorial disk, and are found enclosed when the bottle is drawn out upon the bank.

There can be little doubt that its presence has been overlooked in the southern rivers of New South Wales, such as the Towamba, Bega, Clyde, Shoalhaven, and others, and that when opportunity has been afforded for a thorough investigation of the fresh-water fauna of the colony, this and many other species which are now considered rare will be found to be comparatively plentiful.

The earliest published record of the occurrence of this Lamprey on the mainland is that of Dr. Klunzinger in 1872 (*Arch. f. Natur. p. 45*), and consists of the curt notice "*Mordacia mordax*, Rich. Murray River. 12 Cm." We learn by a note (*l.c. p. 17*) that all the species sent to Klunzinger from the Murray River were taken near its mouth, and this therefore is the most westerly point from which I have been able to ascertain its presence.

During the same year in which Klunzinger's paper appeared Count Castelnau contributed to the Proceedings of the Zoological and Acclimatisation Society of Victoria a more full and interesting account of this Lamprey than any of his predecessors; his examples were collected in the lower portion of the Yarra, where he considered them to be common. He remarks that "their motions are very rapid; they are very voracious and pursue any object in the water,

and they adhere to it with an extraordinary and ferocious tenacity."

From the above quotation one gathers that prior to 1872 these Lampreys were not only common in the Yarra, but that it was an easy matter to study their habits there; how different it is at the present day may be judged from the following:—"*Mordacia* seems sporadic and very rare generally; we got a few floating dead during the summer before last in the tidal Yarra" (*T. S. Hall, in lit. July, 1896*).

In his Catalogue of Tasmanian Fishes (*Proc. Roy. Soc. Tas. 1882, p. 141*) Mr. R. M. Johnston records this Lamprey as "abundant at certain seasons, clinging to the sides of perpendicular rocks under mill-shoots, Cataract Gorge, North Esk, Launceston;" and again (*p. 62*) speaking generally of the Tasmanian species, "the Lamprey, though abundant in some rivers, seems not to be in favour in the market, as they are rarely seen there." Notwithstanding this alleged abundance I have found it impossible to obtain a single specimen from the island.

Total length to 450 millimeters.

Type in the British Museum.

In the preparation of this article I have been able to examine seven specimens having a length of from 125 to 418 millimeters; four of these were collected in the lower Yarra, and were kindly forwarded to me by Sir Frederick McCoy (1) and Mr. T. S. Hall (3) of the Melbourne University; two are in the Macleay Museum, from the Nepean River and Tasmania respectively, and the seventh, also from the Yarra, belongs to Mr. J. P. Hill of the Sydney University.

For the opportunity of seeing two ammocœtes I am also indebted to the kindness of the latter gentleman, to whom they were given by Prof. Baldwin Spencer.

Petromyzonidæ.

Petromyzontidæ, Risso, Eur. Mérid. iii. p. 99, 1826.

Petromyzonidæ, Bonaparte, Saggio, &c. p. 41, 1832.

A single median tuberculigerous suproral lamina developed from the upper arch of the annular cartilage. Labial fringe more or less conspicuous. Other characters similar to those of the Order.

Seven recent genera are recognised as valid.

Etymology:—*πέτρος*, a stone; *μυζάω*, to suck; in allusion to the habit of clinging to stones and other substances by means of the oral disk.

Distribution:—Seas and fresh waters of the temperate and subtropical regions of both hemispheres, four genera belonging to the arctogæan and three to the austrogæan fauna, two of which latter inhabit Australian waters.

Analysis of the Australasian Genera.

Body elongate and slender; head small; suctorial disk very small, longer than broad, extending backwards midway to the eye; outer lip present, continuous behind; surface of disk plicated; no gular pouch; dental plates smooth; discal teeth approximate; ventribasal plate of tongue usually tricuspid; origin of first dorsal on the middle third of the body; head and trunk with conspicuous series of open pores, forming on the latter a well-marked lateral line ... ...
VELASIA, p. 407.

Body rather short and stout; head large; suctorial disk very large, broader than long, extending backwards more than midway to the eye; outer lip rudimentary; surface of disk smooth; gular pouch present; dental plates grooved; discal teeth widely separated; ventribasal plate of tongue bicuspid; origin of the first dorsal on the last third of the body; no series of pores on the head or trunk ... ...
GEOTRIA, p. 420.

VELASIA.

Velasia, Gray, Proc. Zool. Soc. London, 1851, p. 142.
Geotria, *part.* Günther, Catal. Fish. viii. p. 508, 1870.
? Neomordacia, Castelnau, Proc. Zool. & Acclim. Soc. Vict. i. 1872, p. 232.

Body elongate and slender, strongly compressed; head moderate, oblong, attenuated and depressed, with narrow rounded snout; suctorial disk small, oval, subinferior, extending backwards about midway to the orbital region, with a smooth free outer lip, along the inner border of which a regular series of short, simple, distant papillæ is inserted anteriorly and laterally; on the rim of the disk is a second series of broad, profusely fringed, foliaceous papillæ, which is continued entirely round the hinder margin of the disk where it is widely separated from the external lip; surface of disk traversed by numerous series of closely set cutaneous ridges arranged more or less obliquely. No gular pouch. Branchial orifices moderate and slit-like, with distinct functional valves in front and behind, the latter fringed. Maxillary dentition consisting of a single transverse, crescentic, quadricuspid plate, the outer cusps being smooth and much larger than the inner pair, their extremities entire; mandibular plate low and crescentic, strongly cuspidate; disk with an inner series of moderate, diversely shaped teeth, from the bases of which radiate series of small, contiguous, graduated teeth, which are embedded in the hinder margin of the discal ridges; no subsidiary teeth behind the mandibular lamina; tongue with a single large plate, smooth on its outer, tricuspid on its inner margin, along either side of its dorsal surface; below with a strong, transverse, basal plate, provided with three (sometimes two*), slender acute cusps directed forwards. Two well developed dorsal fins, the anterior inserted far behind the middle of the body, the posterior much the larger and separated from the caudal by a moderate interspace; caudal fin well developed, continued around the extremity of the tail by a low, rayed membrane. Tail long, the vent situated below the origin of the second dorsal fin. Head with series of small, open pores; a series of widely separated pores along the middle of the trunk and along the bases of the fins.

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*When the median cusp is absent the remaining two are widely separated at the base, not contiguous as in *Geotria*.

Etymology:—Unknown.

Type:—*Velasia chilensis*, Gray.

Distribution:—Coasts and rivers of south-eastern and southern Australia; ?South-western Australia; Tasmania; New Zealand; Chile.

VELASIA STENOSTOMUS.

Geotria chilensis, part., Günther, Catal. Fish. viii. p. 509, 1870.

Geotria australis, (not Gray) Castelnau, Proc. Zool. & Acclim. Soc. Vict. i. 1872, p. 227 (1873) *and* Edib. Fish. Vict. p. 17, 1873; Lucas, Proc. Roy. Soc. Vict. (2) ii. 1890, p. 47.

Geotria chilensis, Hutton, Fish. N. Zeal. p. 87 *and* (Hector) p. 132, 1872 *and* Trans. N.Z. Inst. v. 1872, p. 271, pl. xii. f. 139 (1873) *and* viii. 1875, p. 216 (1876) *and* xxii. 1889, p. 285 (1890); Macleay, Proc. Linn. Soc. N.S. Wales, vi. 1881, p. 384; Sherrin, Handb. N.Z. Fish. p. 36, 1886; Gill, Mem. Nat. Ac. Sc. Washingt. vi. p. 110, 1893 (not *Velasia chilensis*, Gray).

? *Petromyzon* sp., Kner, Voy. Novara, Fisch. p. 421, 1865.

? *Yarra singularis*, Castelnau, Proc. Zool. & Acclim. Soc. Vict. i. 1872, p. 231 (1873); Macleay, l.c. p. 385; Lucas, l.c.

? *Neomordacia howittii*, Castelnau, l.c. p. 232; Macleay, l.c. p. 383; Lucas, l.c. p. 46.

Narrow-mouthed Lamprey.

Disk oval, its width when fully expanded less than its length, its posterior margin reaching backwards midway to the vertical from the middle of the eye. Eyes rather inconspicuous, the nasal tube opening between their anterior margins. The distance between the extremity of the snout and the nasal opening is $16\frac{2}{5}$ to $17\frac{1}{4}$ in the total length and $1\frac{3}{5}$ to $1\frac{3}{4}$ in that preceding the first branchial orifice, which is situated a little nearer to the last branchial orifice than to the tip of the snout; the space between the last orifice and the extremity of the snout is $5\frac{2}{5}$ to $5\frac{1}{2}$ in the total length. Maxillary plate smooth; the inner cusps triangular

and acute, the notch between them deeper than those which separate them from the lateral cusps, which are much longer and broader, with the inner border acute and convex, the tip pointed, and the outer border obtusely rounded and almost linear, not separated by a groove from the basal portion of the plate; mandibular plate with eleven short, blunt cusps, the outer one at each side and the median one inappreciably larger; inner series of discal teeth large, triangular and acute in front, broad and chiselled on the sides and behind; the middle teeth behind the maxillary plate are as large as the lateral ones; these teeth are twenty-six in number, and the anterior pair correspond to the inner maxillary cusps; in front of the interspace between the anterior pair a series of five teeth, which gradually decrease in size from within, extend in a straight line to the outer rim of the disk; from each of these a curved series of similarly developed teeth radiates outwards and backwards on either side; the disk is armed laterally with similar series of graduated teeth, each row corresponding to one of the enlarged inner teeth and being so strongly bent backwards towards the outer margin as to assume a subconcentric appearance; the surface of the disk is divided into series of low dermal ridges, on the inner posterior border of which the teeth are embedded; these ridges are set so close together that the teeth of one ridge overlap the succeeding ridge; behind the mandibular plate there are no teeth outside of the circumgular series; the tongue is armed with a single pair of dorsolateral plates, each of which is swollen and entire on its outer border and bears on its inner three strong acute cusps, the anterior of which is the smaller, the others being subequal; the transverse ventribasal plate is strongly tricarinate on its inner surface, each of the carinæ being produced into a long, slender cusp, the tips of which are acute and slightly curved upwards; the median cusp is as long as the outer pair. The vent is situated a little behind the origin of the second dorsal; the length of the tail is 4 to $4\frac{3}{5}$ in the total length. The distance between the origin of the first dorsal fin and the tip of the tail is $1\frac{1}{2}$ to $1\frac{2}{3}$ in its distance from the extremity of the snout;

both dorsal fins rise gradually from the dorsal integument in front but terminate in a distinct though short posterior border; the outer border of the first dorsal fin is convex, its apical portion being situated somewhat in advance of the middle of the fin, and the length of its base is a little more than the interdorsal space and $1\frac{1}{2}$ to $1\frac{3}{5}$ in the base of the second, the outer border of which rises somewhat abruptly to above the origin of the median basal third and slopes gradually downwards from thence to its junction with the short posterior border, the anterior border being linear or somewhat convex; its height at the apex is one-third to one-half more than that of the first dorsal; the length of the tail behind the second dorsal is 1 to $1\frac{1}{2}$ in the base of that fin, which is entirely separated from the caudal by an interspace equal to about half the length of the latter fin; the caudal lobes are equally developed and are connected round the extremity of the tail by a low rayed membrane. A series of open pores extends from the throat along the rostral canthus to the antero-superior angle of the eye, where it curves downwards, and ultimately encircles three-fourths of the orbital ring, from the postero-superior angle of which it slopes backwards and downwards in the direction of the first branchial orifice; there is a short series of similar pores above and behind the posterior angle of the closed disk, and a few others along the lower surface of the head; the lateral line is indicated by a series of pores which extend along the middle of the sides of the trunk, and there are similar series along each side of the bases of the fins.

Back dark slate-colour, belly and the greater portion of the sides bronze, the line of demarcation well defined especially on the tail; head dark gray above, silver gray on the sides and below, the latter colour extending backwards along the branchial region; fins yellowish, broadly margined with slate-colour.

The following is Castelnau's description of the colours in the fresh example :—

"Dark blue on the back, silvery on the sides and belly; on the middle of the back, a little before the insertion of the first dorsal,

begins a space of brilliant green, which extends to the tail; fins red, bordered with black."

Capt. Hutton describes the species as having "a broad band of green down each side of the back, the median line and the whole of the lower surface being pale brownish-white."

The brilliant green stripe on each side of the back appears, therefore, to be very distinctive of this Lamprey when alive or recently killed as compared with the uniform black or dark brown of the upper surface of *Geotria australis*.

It will be seen from the synonymy that I have included both of Castelnau's new species as synonyms of *Velasia stenostomus*, though from the size of the specimens, the insufficiency of the descriptions and the destruction or loss of the type,* it will always be impossible to say whether I am justified in my conclusions or, indeed, to what species his immature and ammocœtal forms should be united. If, however, the types are extant and on examination show that my identification is correct in one or other instance, Castelnau's name must necessarily have priority over mine.

Yarra singularis.

The following are the points in Castelnau's description which induce me to believe that his *Yarra singularis* is founded on an ammocœte of the Narrow-mouthed Lamprey. No generic diagnosis of *Yarra* was attempted by its author.

(1). "The body is elongate, being twenty-three times as long as high."

This character might apply with almost equal force either to this species or to *Mordacia mordax*; but when these two Lampreys (in the adult state) are laid side by side it will be seen that *Velasia* is noticeably the more slender of the two. This character could not possibly apply to *Geotria*.

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* These types may possibly be in the Paris Museum, where a part at least of Castelnau's collection is said to have gone.

(2). "The upper lip is flat and considerably prolongated over the buccal aperture."

This inferior position of the disk is also true of *Mordacia* and *Velasia*, but not of *Geotria*.

(3). "The lateral line is well marked in all the length of the body."

In my two adult examples of the Narrow-mouthed Lamprey there is a conspicuous series of open pores down the middle of each side of the body, homologous to the lateral line in the true fishes; in neither of the other genera is there any trace of such line.

(4). "There is only one dorsal, which begins at about two-thirds of the length of the body and is joined with the caudal and anal."

The posterior position of the origin of the dorsal fin is a distinct character of the Australian Petromyzonids, and entirely precludes the possibility of this example being a larval *Mordacia*, in which genus the fin commences in the adult at no great distance—one-fourth to two-fifths—behind the middle of the body, and it is not conceivable that the permanent anterior portion of the fin should develop after the metamorphosis has taken place, rather than that it should be isolated by the absorption of the intervening membrane. The want of accuracy in the expression "about two-thirds" makes it impossible to judge absolutely between the claims of *Velasia* and *Geotria*, but the balance is somewhat in favour of the latter, in which the insertion of the dorsal fins in the adult is distinctly more posterior than in the former.

The continuity of the two dorsal fins and of the second dorsal with the caudal is merely indicative of the ammocœtal character of the individual, as also is the absence of eyes and teeth.

Two other characters in Castelnau's description apparently favour the claims of *Geotria*; namely, that the body "is entirely divided in annular rings" and that "the skin of the throat is rather extensible."

Taking into consideration the small size and imperfect development of the specimen, I do not consider that these characters can be held to equal in importance the tenuity of the body and the presence of the lateral line.

Castelnau's reason for rejecting this ammocœte as the larval form of a *Geotria* seems to be mainly based on the fact that he had previously received "a very young individual, only three inches long, having exactly the same form, the same dimensions, and the same dentition" as the specimen of *Geotria australis* from which his description and measurements of the adult were drawn up, and which I shall show further on to have been in truth a *Velasia stenostomus*. His words are:—"I should have thought this might be the first state of *Geotria*,* but we have just seen that I had a still smaller specimen of this which has entirely the form of the adult."

That the length of the unique example of *Yarra singularis* was "four and three-eighth inches," or one and a-half times the length of the perfectly formed individual mentioned above, is not sufficient reason for denying its identity with the ammocœte of *Velasia*; the difference in size is capable of explanation in at least two ways, thus:—On the one hand the smaller specimen which, having developed teeth, must have passed the ammocœtal stage, may possibly have been the young of the true *Geotria australis*, which, as we shall subsequently show, occurs also on the Victorian coast, while on the other hand the metamorphosis may in this individual case have been retarded from some cause, or at all events incomplete.

Neomordacia howittii.

In his diagnosis of *Neomordacia* Castelnau relies for the validity of his genus on the following unstable character:—

It "has no first dorsal, or rather has only one dorsal, separate and rather distant from the caudal."

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* Lege, *Velasia*. Castelnau does not appear to have ever seen a true *Geotria australis*.

The uninterrupted connection of the dorsal fin is of course only significant as showing the immaturity of the individual, and is, therefore, of no value as a generic character; this last sentence, however, is sufficient to separate the species from *Mordacia*, in which at all ages the dorsal and caudal fins are more or less distinctly united, and in examples up to 125 millimeters are conspicuously so.

The presence of "fringes round the mouth" is also peculiar to *Velasia* and *Geotria*, the external lip and discal rim of *Mordacia* being almost smooth.

The tenuity of the body and the absence of dilatation in the head are, however, characters which belong to *Velasia* as opposed to *Geotria*, and I have, therefore, decided to associate Castelnau's *Neomordacia howittii* with *Velasia stenostomus*.

Returning to the adult Lamprey, my reasons for considering that Castelnau's specimen was *Velasia stenostomus* and not *Geotria australis* as determined by him, will be found below, the more important points of that author's description being taken seriatim.

(1). "The maxillary lamina is formed of four teeth, the exterior of which are flat lobes, and the two interior ones long, conical, pointed teeth."

This gives a fair description of the maxillary cusps of *Velasia* in which the inner cusps are as described and the outer are simple and smooth, while in *Geotria* the inner cusps are lanceolate and the outer notched and grooved.

(2). "Suctorial teeth in numerous transverse series, those situated backwards larger than the others."

The number of the series of discal teeth in *Velasia* and *Geotria* is about the same, but from the great expansion of the disk in the latter they appear to be much less numerous than in the former, to which, therefore, the wording of Castelnau's paragraph would more naturally point; in *Velasia* too the posterior discal teeth are as large as the inner lateral ones, while in *Geotria* they are minute.

(3). "Lingual teeth two in number, straight, strong, and conical."

Without a re-examination of the specimen it is impossible to say whether there were in fact only two ventribasal cusps, as the third one might have been overlooked, either through careless or defective examination as is the case with the specimen most kindly forwarded to me from the British Museum in which the median cusp is as fully developed as either of the lateral ones; sometimes, however, it is absent as in Mr. Hill's specimen, but in that case the bases of the lateral cusps are widely separated.

(4). "The distance between the two dorsals and the base of the caudal is a little more than the diameter of the mouth."

It appears to me that this character in itself indubitably proves the identity of Castelnau's Lamprey with *Velasia* as will be seen by the following measurements taken from my own specimens:—In my Tasmanian type of *Velasia stenostomus* the longitudinal (longer) diameter of the closed suctorial disk is 16 millimeters and the dorso-caudal interspace – which is, I presume, what Castelnau intends—is 15; in *Geotria australis* on the contrary the longitudinal (shorter) diameter of the expanded—and, therefore, further shortened—disk is 27 millimeters and the dorso-caudal interspace only 12, or less than a half.

(5). "The diameter of the mouth is equal to half the distance from the end of the snout to the anterior edge of the eye."

This applies much more closely to the small-mouthed *Velasia* than to the large-mouthed *Geotria*, in which the disk extends full two-thirds of the preorbital portion of the head.

(6). The colours are those of *Velasia*.

In the table of measurements given by Castelnau we also find corroborative evidence of the correctness of my views, while on the other hand certain of the dimensions given are curiously subversive of those views but more in the direction of *Mordacia* than of *Geotria*. The following table has been drawn up for comparison, the measurements in columns 1, 3, and 4 being taken from specimens in my collection, while those in column 2 are from

Castelnau's figures, the circumference of the body being omitted as unnecessary.

	1	2	3	4
	V. stenostomus.	*G. australis*, Cast. = *V. stenostomus.*	*G. australis.*	*M. mordax.*
i. Total length (in millimeters)	468	513	375	413
ii. Muzzle to centre of eye to total length ...	$14\frac{2}{5}$	$18\frac{1}{5}$	$8\frac{1}{5}$	$19\frac{2}{3}$
iii. Muzzle to first branchial orifice to total length	10	$13\frac{3}{5}$	$6\frac{1}{4}$	$12\frac{1}{2}$
iv. Muzzle to last branchial orifice to total length	$5\frac{1}{2}$	$6\frac{1}{2}$	$3\frac{3}{4}$	$6\frac{7}{10}$
v. Origin of first dorsal to tip of tail to its distance from tip of snout	$1\frac{1}{2}$	$1\frac{3}{5}$	$2\frac{1}{5}$	$1\frac{2}{5}$
vi. Interdorsal space to first dorsal	$1\frac{1}{5}$	$1\frac{1}{15}$	$1\frac{2}{5}$	1
vii. Base of first dorsal to that of second ...	$1\frac{1}{2}$	$1\frac{1}{10}$	$1\frac{3}{10}$	$2\frac{1}{5}$
viii. Dorso-caudal interval to caudal	$2\frac{1}{5}$	$1\frac{2}{5}$	$2\frac{2}{5}$	$2\frac{5}{9}$
ix. Tail to total length	$4\frac{1}{2}$	$3\frac{9}{10}$	$5\frac{9}{10}$	$7\frac{1}{7}$

Of all these measurements only one (vii.) of Castelnau's shows a nearer approach to my *Geotria australis* than to *Velasia stenostomus*, while the two most important (v. and ix.) distinctly support the latter.

The three measurements connected with the head (ii. to iv.) are so curiously similar to those of my *Mordacia* that I cannot refrain from conjecturing that Castelnau had an example of each species (*Velasia* and *Mordacia*) before him, and somehow got the dimensions mixed; and if further evidence is necessary as to the probable truth of this conjecture, I may mention that in the table of measurements of *M. mordax* given by Castelnau (*l.c. p. 230*) the distance between the extremity of the snout and the centre of the eye is contained $14\frac{1}{5}$ times in the total length, or nearly the same as that in my *V. stenostomus*. In the same table the length

of the first dorsal is erroneously given as $6\frac{1}{2}$ inches; this is an evident *lapsus calami* for $1\frac{1}{2}$ inches.

Taking all the characters which I have referred to above, for or against, together I consider that I am quite justified in my association of Castelnau's species with *Velasia stenostomus*.

Petromyzon sp.

Kner's description of the ammocœte from the Waikato River, New Zealand (*Voy. Novara, Fisch. p. 421*) gives no characters on which any accurate judgment as to its relationship can be based; the remark, however, that "the cavity of the suctorial disk is closely beset with papillæ" is clearly more indicative of affinity to *Velasia* than to *Geotria*. Günther is, therefore, probably right in conjecturing that "it is perhaps the young state of" *Geotria chilensis* (= *Velasia stenostomus*).

There is, however, one other character given by Kner which puzzles me; he says:—"The large triangular nostril lies nearly above the margin of the sucking disk in the middle of the forehead." Now in none of the species is the nostril situated "in the middle of the forehead," though it is of course placed on the middle longitudinal line of the head between or nearly between the anterior borders of the eyes; again the posterior margin of the suctorial disk does end beneath the middle of the forehead, *i.e.*, of the preorbital space, in *Velasia*, but not beneath the nostril; it ends beneath the nostril only in *Mordacia*, which genus is not found in New Zealand; if it were I should unhesitatingly consider this little animal to be the larval form of the latter genus.

Breeding:—As with *Mordacia mordax* nothing definite is known of the propagation of this species, but it is worthy of note that such ammocœtes as have hitherto been recorded were all obtained in tidal waters, and as before their metamorphosis these animals remain buried in the mud, it would appear that the adults do not necessarily seek fresh water before depositing their spawn, nor is the purity of the element requisite to the development of the ovum.

Uses :- That these Lampreys were a common and favourite article of food among the Maoris we gather from the New Zealand writers; Sherrin tells us that "they are greatly esteemed by the Natives, who call them *Piharau* and used to pot them in large quantities. Maori chiefs, as well as Henry I., have died from a surfeit of Lampreys, the chiefs having the pick of large catches of all kinds of fish set apart for them."

Further on he writes :—"It is necessary to bear the construction of the mouth of the Lamprey in mind to understand what the Natives mean when they say they see them 'sucking their way up a waterfall in streams in hundreds at a time.' When thus found a net is placed at the foot of the fall, and the fish being detached fall into the net and are thus captured. They are also often found in their eel-weirs. They ascend the Waikato (and probably other rivers) when the whitebait is also ascending. If cooked in a hangi they have to be eaten with care, and a certain fluid they contain, the Natives say, must be expressed, or its effect will be similar to that induced by the eating of a certain kind of shark—the loss of the gourmand's skin. Cooked as Europeans would cook them, this apprehension would not be entertained."

Dr. Hector also writes :—"Most of the New Zealand rivers are visited early in summer by shoals of Lampreys, which are stated to be excessively delicate and well flavoured."

At the time this was written the occurrence of *Geotria australis* in New Zealand was unknown, nevertheless as the statement was based on hearsay evidence it must be taken as referring to both species.

Distribution :—Coasts and rivers of Victoria, South Australia, Tasmania, and New Zealand; ? West Australia.

In New Zealand the Whanganui, Waikato, and Raiwaka Rivers are specially referred to; the species inhabits, therefore, both the North and the South Islands.

I have placed a note of interrogation against the West Australian distribution usually accorded to this species on the strength of the British Museum Catalogue, in which it is recorded from "Swan River;" though without doubt the West Australian

river is the most widely known, the name itself is so little distinctive that I am inclined to believe that some stream, possibly in Tasmania, where it has now been proved beyond question to occur, is intended.

Type in my possession.

Total length to 550 millimeters.

Three specimens have been available to me in the preparation of this description; for the first I am indebted to the authorities of the British Museum, who, on learning that I was working at the Australian Lampreys, with great kindness sent me one of the New Zealand examples recorded in Dr. Günther's Catalogue as *Geotria chilensis*, while a second example from the same Colony was lent to me by Mr. J. P. Hill, only the anterior half of this individual having been preserved; the third was forwarded to me from Tasmania by Mr. Morton and measures 468 millimeters.

Geotria.

Geotria, Gray, Proc. Zool. Soc. London, 1851, p. 238.

Body rather short and stout, strongly compressed; head large, oblong, with broad, rounded snout; suctorial disk very large, elliptical, subterminal, extending backwards more than half way to the orbital region, without free external lip, its rim thick and fleshy, and bearing on its inner margin two series of fringed, foliaceous papillæ; the hinder margin of the disk is low and bears a single series of similar but much enlarged papillæ; surface of disk smooth. Gular pouch present. Branchial orifices large and slit-like, with a rudimentary valve in front and behind. Maxillary dentition consisting of a single transverse, crescentic, quadricuspid plate, the basal portion divided from the cusps by a deep groove; outer cusp notched at the extremity; mandibular plate low and crescentic, smooth or feebly cuspidate; disk with an inner series of rather large, diversely shaped teeth, from each of which radiates a series of small, distant teeth; the series are curved obliquely backwards and widely separated; a single transverse series behind the mandibular plate, the median teeth the smallest; tongue with a single large plate, smooth on its outer,

quadricuspid on its inner margin, along either side of its dorsal surface; below with a strong, transverse, basal plate, provided with two stout, sharp cusps directed forwards. Two well developed dorsal fins separated by a moderate interspace, inserted on the posterior third of the body, the second entirely disconnected with the caudal and not much larger than the first; caudal fin moderate, continued around the extremity of the tail by a low rayed membrane. Tail short; the vent situated below or nearly below the origin of the second dorsal fin. Head and body without conspicuous series of pores.

Etymology:—Unknown.

Type:—*Geotria australis*, Gray.

Distribution:—Coasts and rivers of Southern Australia, Tasmania, and New Zealand; Chile and the Argentine Republic.

Dr. Günther, in the course of some remarks on *Geotria australis*, writes thus:—

"Philippi (*Wiegm. Arch. 1857, p. 266*)* has described a Lamprey from Chile under the name *Velasia chilensis*; the example was provided with the sac at the throat and the description agrees with *Geotria australis*; so that we must assume either that this latter species occurs not only in Australia but also in Chile, or that *Velasia chilensis* at a certain stage of development is provided with a gular sac. If the latter be the case the specific distinction of the two species would be questionable" (*Catal. Fish. viii. p. 509*).

From the above quotation it is evident that some species of Lamprey provided with a gular sac inhabits the rivers of Chile, and if I am correct in attributing that character to *Geotria* alone, it follows that the genus is represented there; but I cannot agree with Dr. Günther that the species is necessarily identical with *G. australis*, and much less that the latter species is indistinguishable from *Velasia chilensis*.

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* I am unable to refer to a copy of this publication.

The function of the extraordinary pouch with which the members of this genus are furnished is quite unknown, nor have any observations as yet been made showing whether its presence is in any way connected with age, sex, or season.

Geotria australis.

Geotria australis, Gray, Proc. Zool. Soc. London, 1851, p. 238, pls. iv. f. 3 & v., *and* Catal. Chondropt. p. 142, pls. i. f. 3 & ii. 1851; Günther, Catal. Fish. viii. p. 508, 1870; Hutton, Trans. N.Z. Inst. v. 1872, p. 272, pl. xii. f. 139a (1873) *and* xxii. 1889, p. 285 (1890); Klunzinger, Sitzb. Ak. Wien, lxxx. i. 1879, p. 429 (1880); Macleay, Proc. Linn. Soc. N.S. Wales, vi. 1881, p. 384; Sherrin, Handb. N.Z. Fish. p. 56, 1886; Gill, Mem. Nat. Ac. Sc. Washingt. vi. p. 110, 1893.

Geotria allporti, Günther, Proc. Zool. Soc. London, 1871, p. 675, pl. lxx; Macleay, l.c. p. 385; Johnston, Proc. Roy. Soc. Tas. 1882, p. 141, *and* 1890, p. 39.

Wide-mouthed Lamprey.

Disk elliptical, its length when fully expanded $1\frac{1}{4}$ in its breadth and $1\frac{3}{5}$ to $1\frac{2}{3}$ in the space between its anterior margin and the eye. Eyes conspicuous, the nasal tube opening between their anterior borders. The distance between the extremity of the snout and the nasal opening is $7\frac{1}{5}$ to $8\frac{3}{4}$ in the total length, and $1\frac{2}{5}$ to $1\frac{1}{2}$ in that preceding the first branchial orifice, which is situated much nearer to the last than to the tip of the snout. The space between the last branchial orifice and the extremity of the snout is $3\frac{1}{4}$ to $3\frac{1}{5}$ in the total length. Maxillary plate grooved; the inner cusps are lanceolate and strongly keeled; they are entirely distinct from one another, the notch between them being as deep as those which separate them from the lateral cusps, which are much longer and broader, and are divided into two subequal portions by the prolongation of the basal groove; the free edge of the inner portion is strongly compressed, sharp,

and entire,* the remainder of the cusp being swollen and the tip obtusely pointed; the external portion is broader than the inner and is more or less truncated; it is as long as or shorter than the inner portion; mandibular plate with ten cusps, the outer one on each side acute and directed inwards and backwards, the other short and blunt, sometimes rudimentary; the inner series of discal teeth are enlarged, triangular and acute in front, broad and chiselled on the sides, those behind the mandibular plate growing gradually smaller towards the middle; these teeth are twenty-eight in number and the anterior pair correspond to the inner maxillary cusps; in front of the interspace between the anterior pair is a series of six teeth, which gradually decrease in size from within and extend in a straight line to the rim of the disk; from these and from the enlarged circumgular teeth extend curved series of graduated teeth; these series are widely separated from one another and the teeth themselves are not in contact basally; there are no small teeth behind the postmandibular series; the tongue is armed with a single pair of dorso-lateral plates, each of which is deeply grooved near its outer border, which is strongly convex, blunt, and entire, while the inner border is quadricuspid, the anterior cusp being only about half the length of the other three, which are subequal in size; the transverse, ventribasal plate is also grooved round the base of the cusps, but is otherwise smooth; the cusps are two in number, long, acute, and directed outwards and slightly upwards; there is a minute median basal cusp behind the plane of the functional pair. The vent is situated beneath the origin of the second dorsal; the length of the tail is $5\frac{1}{3}$ to $6\frac{2}{3}$ in the total length. The distance between the origin of the first dorsal fin and the tip of the tail is 2 to $2\frac{1}{4}$ in its distance from the extremity of the snout; both dorsal fins rise gradually from the dorsal integument in

* Günther describes the outer cusps in *G. allporti* as being "finely serrated on the inner margin," but there is no trace of any such serrature in either of my specimens, though they agree perfectly in the transversely plicated body.

front, but terminate in a distinct though short posterior border; the outer border of the anterior fin is evenly convex, its apical portion being situated above the middle of the base of the fin, and the length of its base is from one-fourth to three-fifths in the interdorsal space and $1\frac{3}{10}$ to $1\frac{2}{5}$ in that of the second dorsal, the outer border of which is also convex throughout, its apex being a little behind the commencement of the median third; its height at the apex is one-fifth more than that of the first dorsal; the length of the tail behind the second dorsal is a little more, equal to, or a little less than the base of that fin, which is entirely separated from the caudal by an interspace, which is equal to about two-fifths of the length of the latter fin; the caudal lobes are subequal in height, but the lower extends forwards much further than the upper; they are connected together around the extremity of the tail by a low rayed membrane. Head and body without series of conspicuous pores. Skin transversely plicated.

Black or dark brown above, lighter below; upper surface of head with a bluish, sides of head with a bronze tinge; lower surface of head, throat, and pouch grayish-white.

Breeding:—Unknown.

Uses:—Similar to the other species.

Distribution:—Having already shown that Castelnau's *Geotria australis* belonged in truth to the preceding species we are now reduced to a bare statement of the habitat of this Lamprey in so far as it can be separated with certainty from that of *Velasia*.

Gray's type specimen is said by Dr. Günther to have come from the "Inkarpinki River, South Australia"; but I have not succeeded in finding the locality of any river with such a name, and it must be remembered that throughout the British Museum Catalogue "South Australia" is used to denote our entire southern sea-board, and not restricted in the territorial sense which is customary here; this, however, is in this case of little consequence, as Count Castelnau informs us that Mr. Pain, by whom the specimen was forwarded to the British Museum, had personally

assured him that he "picked it up on Brighton Beach, Hobson's Bay." As, however, Klunzinger records this Lamprey from King George's Sound it may be presumed that the species visits the rivers of our southern coast in greater or less numbers during the spawning season.

Under the name *allporti*, Johnston describes the Pouched Lamprey as being "not uncommon in fresh water, Derwent, North Esk, St. Leonards."

From New Zealand I can find no record except that of Capt. Hutton, who claims to have received it from Stewart Island.

Total length to 500 millimeters.

Type in the British Museum, as also is that of *allporti*.

Only two specimens were available to me for examination, for both of which I have to thank Mr. Alexander Morton, to whose generous assistance I am greatly indebted for this opportunity of establishing the position of our Australian Hyperoartians on a more stable basis than they have hitherto enjoyed. Both my examples were collected in Tasmania and measure respectively 325 and 375 millimeters.

In order to render this paper as perfect as the means at my disposal permit I append the following brief diagnosis of the third austrogæan genus as given by its author.

Exomegas.

Exomegas, Gill, Proc. U.S. Nat. Mus. v. 1882, p. 524.

"Discal teeth in concentric series, the outer containing the largest teeth (about 24 on each side); lingual teeth three, large, pointed, and curved, the median smallest, all standing on the same base."

Etymology: ἔξω, without; μέγας, large; in allusion to the enlarged size of the outer discal teeth.

Type:—*Exomegas macrostomus*, Gill = *Petromyzon macrostomus*, Burmeister.

Distribution:—Atlantic coast of South America (Argentine Republic); very rare.

For further information concerning this form consult Burmeister, Anal. Mus. Buenos Aires, pt. 5, 1868, Act. Soc. Palæont. p xxxvi., and Berg, Anal. Mus. La Plata, 1893.